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**Rune**

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(54) **MOBILE TELECOMMUNICATIONS NETWORK AND METHOD FOR IMPLEMENTING AND IDENTIFYING HIERARCHICAL OVERLAPPING RADIO COVERAGE AREAS**

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(51) **Int. Cl.<sup>7</sup>** ..... **H04Q 7/20**

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(58) **Field of Search** ..... **455/432, 435, 455/443, 444, 446, 448, 449, 456, 422, 433, 445**

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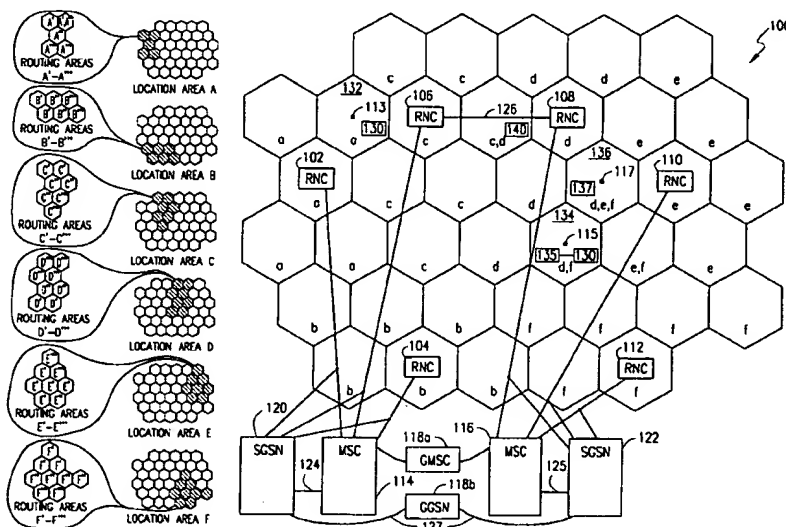
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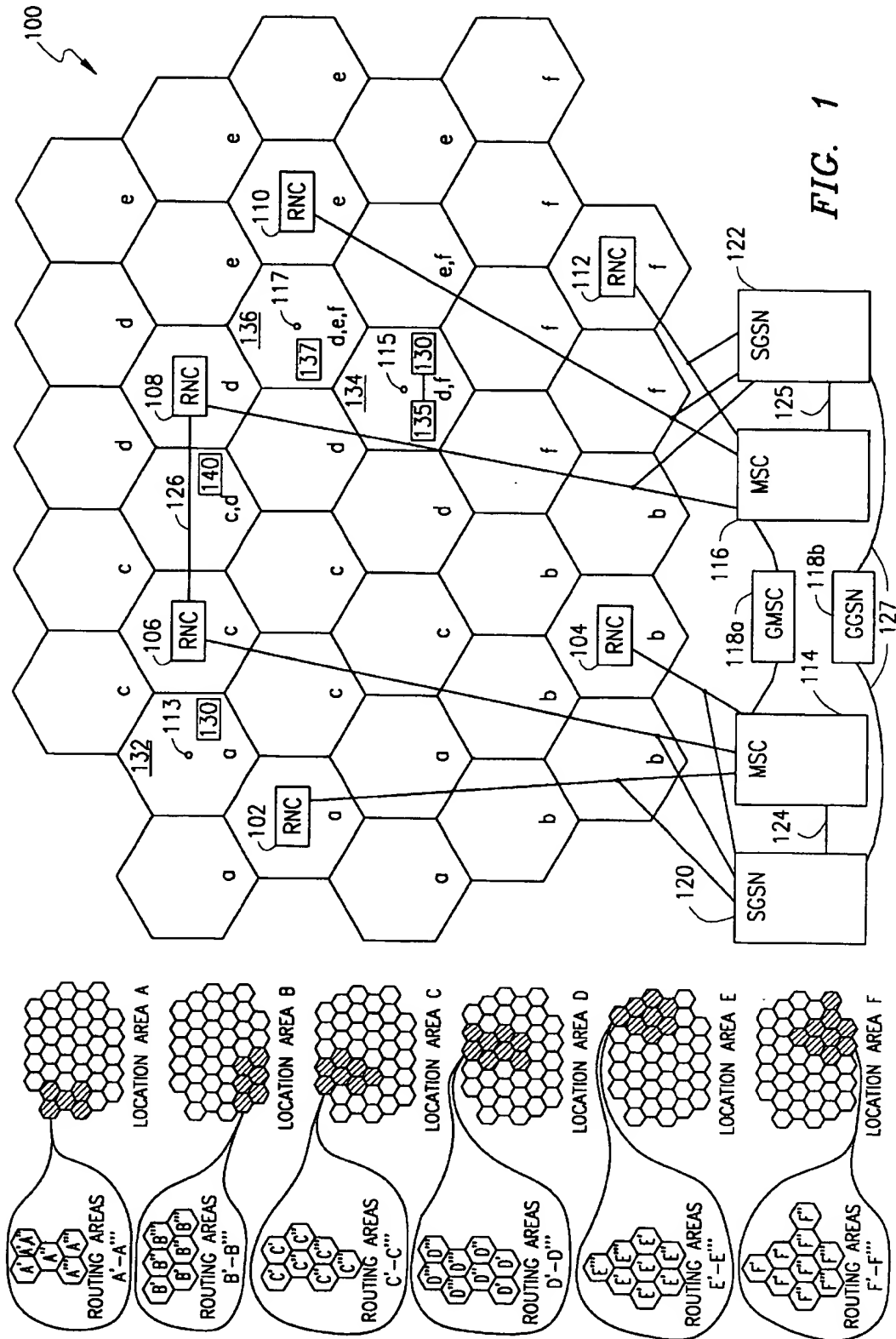
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#### ABSTRACT

A mobile telecommunications network and method for identifying hierarchical and overlapping radio coverage areas including a combination of at least one location area and at least one routing area. More specifically, the mobile telecommunications network includes a first switching center and a second switching center coupled to a controller that manages a plurality of location areas and a plurality of routing areas. The location areas and routing areas are also controlled by the first switching center and the second switching center, respectively. The mobile telecommunications network further includes a plurality of cells, where the cells accommodate at least one of the location areas and at least one of the routing areas. Lastly, the mobile telecommunications network further includes an identification system for identifying at least one combination identifier representative of the at least one location area and the at least one routing area accommodated by each cell.

86 Claims, 8 Drawing Sheets





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Further in accordance with the present invention, there is provided a second embodiment of a method and mobile telecommunications network where a base transceiver station located in a cell operates to transmit a combined location code representative of at least one location area and a combined routing code representative of at least one routing area accommodated by the cell.

#### BRIEF DESCRIPTION OF THE DRAWINGS

A more complete understanding of the method and apparatus of the present invention may be had by reference to the following detailed description when taken in conjunction with the accompanying drawings wherein:

FIG. 1 is a diagram illustrating the general architecture of a mobile telecommunications network incorporating hierarchical overlapping location areas and routing areas in accordance with the present invention;

FIG. 2 is a diagram illustrating a first embodiment of an identification system used within the mobile telecommunications network shown in FIG. 1, where the identification system operates to identify a cell accommodating one location area and multiple routing areas;

FIG. 3 is a diagram illustrating the first embodiment of the identification system used within the mobile telecommunications network shown in FIG. 1, where the identification system operates to identify another cell accommodating multiple location areas and one routing area;

FIG. 4 is a diagram illustrating the first embodiment of the identification system used within the mobile telecommunications network shown in FIG. 1, where the identification system operates to identify yet another cell accommodating multiple location areas and multiple routing areas;

FIG. 5 is a diagram illustrating exemplary location updates and routing updates that may be initiated by a roaming mobile terminal and a mobile terminal being turned on;

FIG. 6 is a diagram illustrating exemplary service areas (e.g., one or more routing areas) incorporating service area flags used in conjunction with a known temporary logical link identity (TLLI) feature;

FIG. 7 is a diagram illustrating a second embodiment of the identification system for identifying hierarchical overlapping location areas; and

FIG. 8 is a diagram illustrating the second embodiment of the identification system for identifying hierarchical overlapping routing areas.

#### DETAILED DESCRIPTION OF THE DRAWINGS

Referring to the Drawings, wherein like numerals represent like parts throughout FIGS. 1-8, there are disclosed two embodiments of an exemplary mobile telecommunications network 100 in accordance with the present invention.

Although the mobile telecommunications network 100 will be discussed with reference to third generation standards (e.g., Universal Mobile Telecommunications System (UMTS) and International Mobile Telecommunications 2000 (IMT-2000)) incorporating an overlapping feature based on the PDC standard and a hierarchical location area structures feature based on the GSM/GPRS standards, those skilled in the art will appreciate that other standards and specifications may also utilize the principles of the present invention. Accordingly, the mobile telecommunications network 100 described should not be construed in such a limited manner.

In order to better describe the present invention, detailed descriptions about the specifics of the two embodiments

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associated with the identification of hierarchical overlapping location areas and routing areas within the mobile telecommunications network 100 are deferred pending a discussion about the architecture of hierarchical overlapping location and routing areas forming the mobile telecommunications network.

Referring to FIG. 1, there is a diagram illustrating the architecture of the mobile telecommunications network 100 incorporating hierarchical overlapping location areas and routing areas in accordance with the present invention. It should be noted that the illustrated configuration of the mobile telecommunications network 100 is only one of many possible configurations that may form the mobile telecommunications network.

For example, there need not be a one-to-one relationship between controllers, mobile switching centers, base transceiver stations, location areas and routing areas as described below. Instead, there may be several location/routing areas served by one controller, and a single location/routing area may include cells that are controlled by more than one controller. The same relationship could be true for mobile switching centers and location/routing areas. In fact, some mobile telecommunications networks do not have controllers and, as such, directly connect the base transceiver stations to the mobile switching centers.

The mobile telecommunications network 100 can use either or both of a plurality of contiguous location areas A-C and overlapping location areas D-F for handling circuit switched calls within a particular geographic area. Each location area A-F includes the group of cells a-f and a radio network controller (RNC) 102, 104, 106, 108, 110 and 112, respectively. The RNCs 102, 104, 106, 108, 110 and 112 in addition to being similar to known base station controllers may interface with one another by way of line 126 (only one shown).

As an illustration, the RNC 102 provides mobile service and manages the location area A and cells a, while the RNC 110 provides mobile service and manages the location area E and cells e. Each cell a-f includes a base transceiver station (BTS) 113, 115 and 117 (only three are shown) for transmitting and receiving mobile telecommunications preferably using mobility management and call control protocols similar to ones defined in the GSM standard. In addition, the RNCs 102, 104, 106, 108, 110 and 112 and BTSs 113, 115 and 117 are collectively referred to as a radio access network (RAN) which generally has responsibility for radio related functions.

A number of the RNCs 102, 104, 106, 108, 110 and 112 can be associated with any number of mobile switching centers (MSCs) 114 and 116. As an illustration, the RNCs 102, 104 and 106 can be controlled by the MSC 114, and the RNCs 108, 110 and 112 may be controlled by the MSC 116. The MSCs 114 and 116 are, in turn, connected to a gateway mobile switching center (GMSC) 118a, which generally functions as an interface between the mobile telecommunications network 100 and, for example, a public switched telephone network (PSTN) (not shown).

In addition to the location areas A-F used in handling circuit switched calls, the mobile telecommunications network 100 can incorporate either or both of a plurality of a contiguous routing areas A'-A'', B'-B'' and C'-C'' and overlapping routing areas D'-D'', E'-E'' and F'-F'' for handling packet switched data calls. The routing areas A'-F'' represent a lower hierarchical level as compared to a higher hierarchical level represented by the location areas A-F. Each routing area A'-F'' may be accommodated by at least

one of the cells a-f and managed by one of the RNCs 102, 104, 106, 108, 110 or 112 in a similar manner as mentioned above with respect to the location areas A-F. It should be understood that any one of the cells a-f can accommodate a combination of one or more location areas and routing areas A'-F".

Each of the RNCs 102, 104, 106, 108, 110 and 112 connect to a serving general packet radio service support node (SGSNs) 120 and 122 (two shown) that control a service area including one or more routing areas. As an illustration, the RNCs 102, 104 and 106 can be controlled by the SGSN 120 that manages the service area including routing areas A'-C", and the RNCs 108, 110 and 112 may be controlled by the SGSN 122 that manages another service area including routing areas D'-F". The SGSNs 120 and 122 are, in turn, connected by way of lines 127 to a GGSN 118b (Gateway GPRS Support Node). It should be understood that a routing area may well cross a SGSN service area border to permit routing area overlapping around the SGSN service area borders.

The SGSNs 120 and 122, MSCs 114 and 116 and GMSC 118a and GGSN 118b are collectively known as a core network which has the responsibility for functions including, for example, mobility management, call control, supplementary services and charging. In addition, the SGSNs 120 and 122 may interface with the MSCs 114 and 116 by way of lines 124 and 126, respectively.

Referring to FIGS. 2-8, there are illustrated the first embodiment (FIGS. 2-6) and the second embodiment (FIGS. 7-8) associated with identifying hierarchical overlapping location areas and routing areas within the mobile telecommunications network 100. The identification of hierarchical overlapping location areas and routing areas and subsequent transmitting of corresponding identifiers (described later) enables a mobile terminal 130 (FIG. 1) to keep track of which location area and/or routing areas it is presently registered to operate within by comparing the transmitted identifiers with stored identifiers. And, if there is no match then a location update and/or a routing update is initiated by the mobile terminal 130 to register with a newly entered location area or routing area. Generally, the mobile telecommunications network 100 is informed whenever the mobile terminal 130 changes location area or routing area so that the mobile telecommunications network can forward incoming traffic to the mobile terminal.

Referring to FIG. 2, there is illustrated an identification system 200 of the first embodiment used to identify a cell accommodating one location area and two routing areas. As an illustration, a cell 132 (FIG. 1) accommodating the location area A and two of the routing areas A' and A" is described. The base transceiver station (BTS) 113 located in cell 132 operates to broadcast to the mobile terminal 130 a unique location area identifier (LAI-A) 202 associated with the location area A. The same LAI-A 202 is broadcast by all of the BTSs located in the cells accommodating the location area A. In addition, the BTS 113 also broadcasts a routing area identifier RAI-A'A 208 associated with the routing area A', and a second routing area identifier RAI-A"A 210 associated with the routing area A". Generally, the routing area identifiers RAI-A' and RAI-A" are only unique within the scope of the location area representing the higher hierarchical level.

Thereafter, the mobile terminal 130 and network 100 each form a first combination identifier 204 and a second combination identifier 206. The first combination identifier 204 includes the LAI-A 202 coupled with a first routing area

identifier (RAI-A'A) 208. And, the second combination identifier 206 includes the LAI-A 202 coupled with a second routing identifier (RAI-A"A) 210. Likewise, the mobile terminal 130 and network 100 each assign a location number 212 for use instead of the LAI-A 202 and two combination numbers 214 and 216 for use instead of the two combination identifiers 204 and 206, respectively. The location number 212, first combination number 214 and the second combination number 216 are shorter than their corresponding identifiers 202, 204 and 206 and as such are more efficient to handle than the entire string of bits associated with the corresponding identifiers.

It should be understood that the combination numbers and location numbers are not used by the mobile terminal 130 during a location or routing update, because the mobile terminal has to indicate the location identifier and routing identifier in another cell where the previous location or routing update was performed. On the other hand, the combination number can be used to make a temporary identity unique within a border cell since the mobile terminal was assigned its temporary identity in a location area and routing area whose identities are included in the broadcast system information present in the cell.

Referring to FIG. 3, there is illustrated the identification system 200 of the first embodiment used to identify a cell accommodating two location areas and one routing area. As an illustration, a cell 134 (FIG. 1) accommodating the location areas D and F and the routing area D' is described.

The BTS 115 located in cell 134 operates to broadcast to the mobile terminal 135 unique location area identifiers LAI-D 302 associated with the location area D and LAI-F 304 associated with the location area F. The same LAI-D 302 and LAI-F 304 are broadcast by all of the BTSs located in the cells accommodating the location areas D and F. In addition, the BTS 115 also transmits two routing area identifiers RAD-D'D 310 and RAI-D'F 312, both associated with the routing area D'.

Thereafter, the mobile terminal 135 and network 100 each form a first combination identifier 306 and a second combination identifier 308 which are not to be confused with the combination identifiers 204 and 206 described in FIG. 2. The first combination identifier 306 includes the LAI-D 302 coupled with a first routing area identifier (RAI-D'D) 310. And, the second combination identifier 308 includes the LAI-F 304 coupled with a second routing area identifier (RAI-D'F) 312. Likewise, the mobile terminal 135 and network 100 each assign a first location number 314 and a second location number 316 for use instead of the LAI-D 302 and LAI-F 304 and two combination numbers 318 and 320 for use instead of the two combination identifiers 306 and 308, respectively. Again, the first location number 314, second location number 316, first combination number 318 and the second combination number 320 are shorter than their corresponding identifiers 302, 304, 306 and 308 and as such are more efficient to handle than the entire string of bits associated with the corresponding identifiers. The first and second location numbers 314 and 316 and the first and second combination numbers 318 and 320 are not to be confused the location number 212 and combination numbers 214 and 216 described with reference to FIG. 2.

Referring to FIG. 4, there is illustrated the identification system 200 of the first embodiment used to identify a cell accommodating three location areas and three routing areas. As an illustration, a cell 136 (FIG. 1) accommodating the location areas D, E and F and the routing areas D', E' and F' is described.